

DEPARTMENT OF THE ARMY FIELD MANUAL

MARINE CORPS FLEET MARINE FORCE MANUAL

FM 101-31-3

FMFM 11-4B

STAFF OFFICERS' FIELD MANUAL
NUCLEAR WEAPONS EMPLOYMENT
EFFECTS DATA

DEPARTMENTS OF THE ARMY AND THE NAVY

FEBRUARY 1968

AIR BLAST TABLE

DAMAGE RADII AGAINST FIELD FORTIFICATIONS

SURFACE BURST

TARGET DESCRIPTION	DEGREE OF DAMAGE	YIELD (KT)			
		.01	.5	10	50
COMMAND POST AND PERSONNEL SHELTER, MODULAR SECTIONS 6 FEET BY 8 FEET WITH TOP 3 FEET TO 5 FEET BELOW GROUND SURFACE, EARTH COVERED, AND COVERED TRENCH ENTRANCE.	MOD	35	85	260	470
	SEV	35	80	245	440
MACHINEGUN EMPLACEMENT, 7 FEET BY 7 FEET, FRAMEWORK EXTENDS 2 FEET ABOVE ORIGINAL GROUND SURFACE, HAS OPEN FIRING PORTS AND OPEN TRENCH ENTRANCE, 3-FOOT TO 5-FOOT MOUND OF EARTH COVERS FRAME- WORK AND EXTENDS DOWN TO THE GROUND SURFACE EXCEPT AT OPENINGS.					
FIRING PORT FACING TOWARDS GROUND ZERO.	MOD	55	125	380	690
	SEV	50	110	340	620
FIRING PORT FACING AWAY FROM GROUND ZERO.	MOD	45	100	300	550
	SEV	40	95	285	520
UNREVETTED TRENCHES AND FOXHOLES WITH OR WITHOUT LIGHT COVER.	MOD	90	200	610	1110
	SEV	70	155	475	860
WIRE ENTANGLEMENTS, DOUBLE APRON BARBED WIRE CONCERTINA					
	SEV	45	115	435	895
	SEV	50	130	505	1035

AIR BLAST TABLE

DAMAGE RADII AGAINST BUILDINGS & STRUCTURES

SURFACE BURST

TARGET DESCRIPTION	DEGREE OF DAMAGE	YIELD (KT)			
		.01	.5	10	50
MULTISTORY BLAST-RESISTANT REINFORCED-CONCRETE BUILDING WITH REINFORCED CONCRETE WALLS, NO WINDOWS.	MOD	70	150	485	875
	SEV	50	110	355	690
MULTISTORY REINFORCED-CONCRETE BUILDING WITH CONCRETE WALLS, SMALL WINDOW AREA, THREE TO EIGHT STORIES.	MOD	90	225	760	1395
	SEV	60	155	555	1095
MULTISTORY WALL-BEARING BUILDING, BRICK APARTMENT-HOUSE-TYPE, UP TO THREE STORIES.	MOD	175	415	1270	2195
	SEV	115	290	975	1755
MULTISTORY WALL-BEARING BUILDING, MONUMENTAL TYPE, UP TO FOUR STORIES.	MOD	120	285	890	1580
	SEV	80	200	665	1255
WOOD FRAME BUILDING, HOUSE-TYPE, ONE OR TWO STORIES.	MOD	210	500	1550	2850
	SEV	140	350	1190	2215
LIGHT STEEL FRAME INDUSTRIAL BUILDING, SINGLE-STORY UP TO 5-TON CRANE CAPACITY.	MOD	65	190	830	1710
	SEV	45	120	580	1280
HEAVY STEEL FRAME INDUSTRIAL BUILDING, SINGLE-STORY, WITH 25- TO 50-TON CRANE CAPACITY.	MOD	55	175	725	1395
	SEV	35	115	520	1075
HEAVY STEEL FRAME INDUSTRIAL BUILDING, SINGLE-STORY, WITH 60- TO 100-TON CRANE CAPACITY.	MOD	50	165	645	1215
	SEV	35	105	455	945
MULTISTORY STEEL FRAME OFFICE-TYPE BUILDING, 3- TO 10-STORY, EARTHQUAKE RESISTANT	MOD	50	120	430	865
	SEV	35	85	305	650
MULTISTORY STEEL FRAME OFFICE-TYPE BUILDING, 3- TO 10-STORY, NON-EARTHQUAKE RESISTANT CONSTRUCTION.	MOD	65	145	535	1095
	SEV	45	105	375	820

AIR BLAST TABLE

DAMAGE RADII AGAINST BUILDINGS & STRUCTURES

SURFACE BURST

TARGET DESCRIPTION	DEGREE OF DAMAGE	YIELD (KT)			
		.01	.5	10	50
MULTISTORY REINFORCED CONCRETE FRAME OFFICE-TYPE BUILDING, 3- TO 10-STORIES, EARTHQUAKE RESISTANT.	MOD	60	135	485	965
	SEV	45	100	345	730
MULTISTORY REINFORCED CONCRETE FRAME OFFICE-TYPE BUILDING. 3- TO 10-STORIES, NON- EARTHQUAKE RESISTANT.	MOD	65	150	595	1170
	SEV	45	105	425	890
HIGHWAY TRUSS BRIDGE, SPANS 46 TO 76 METERS.	MOD	60	150	515	975
	SEV	40	105	375	755
FLOATING BRIDGES, RANDOM ORIENTATION.	MOD	55	145	580	1220
	SEV	35	100	410	900
UNDERGROUND PROTECTIVE STRUCTURES.					
STEEL OR CONCRETE ARCH OR DOME.					
DESIGNED TO RESIST 100 PSI FROM MEGATON RANGE WEAPON.					
20-FOOT SPAN	MOD	35	80	275	485
	SEV	25	55	205	385
50-FOOT SPAN	MOD	15	55	240	455
	SEV	10	35	170	350
DESIGNED TO RESIST 300 PSI FROM MEGATON RANGE WEAPON.					
20-FOOT SPAN	MOD	15	45	170	305
	SEV	10	30	120	240
50-FOOT SPAN	MOD	10	25	125	265
	SEV	5	15	90	195
REINFORCED CONCRETE BOX WITH 20-FOOT SPAN,					
100 PSI RESISTANT	MOD	25	70	265	485
	SEV	15	45	200	375
300 PSI RESISTANT	MOD	15	40	160	435
	SEV	10	30	115	235

AIR BLAST TABLE

DAMAGE RADII AGAINST MILITARY FIELD EQUIPMENT

SURFACE BURST

TARGET DESCRIPTION	DEGREE OF DAMAGE	YIELD (KT)			
		.01	.5	10	50
TRACKED VEHICLES	MOD	25	85	350	720
	SEV	15	55	240	495
ARTILLERY	MOD	30	105	435	895
	SEV	25	85	350	720
WHEELED MILITARY VEHICLES	MOD	70	190	725	1490
	SEV	40	105	400	815
SUPPLY DUMPS	SEV	20	60	230	470
RADIOS AND ELEC FIRE CONTR EQUIP	SEV	50	130	505	1035
OPEN-GRID-RADAR-ANTENNAS	SEV	125	330	1270	2600
RAILROAD ROLLING STOCK					
END-ON ORIENTATION	MOD	70	160	485	885
	SEV	65	145	450	815
45 DEG ORIENTATION	MOD	60	165	635	1300
	SEV	40	110	425	870
SIDE-ON ORIENTATION	MOD	75	195	745	1520
	SEV	60	155	595	1225
RAILROAD LOCOMOTIVES					
END-ON ORIENTATION	MOD	50	115	350	630
	SEV	30	70	215	390
45 DEG ORIENTATION	MOD	50	130	490	1005
	SEV	25	65	245	500
SIDE-ON ORIENTATION	MOD	50	130	500	1020
	SEV	25	70	275	565
ENGINEER EQUIPMENT					
TRUCK-MOUNTED	MOD	70	190	720	1475
	SEV	45	115	445	910
EARTH-MOVING	MOD	35	100	375	770
	SEV	30	85	330	675
PARKED COMBAT AIRCRAFT (RANDOM ORIENTATION)					
JET FIGHTER AIRCRAFT	MOD	140	320	985	1790
	SEV	110	245	750	1360
JET BOMBER AIRCRAFT	MOD	210	475	1445	2625
	SEV	160	360	1105	2005
PROPELLER FIGHTER AIRCRAFT	MOD	160	360	1105	2005
	SEV	140	320	985	1790
HELICOPTER AIRCRAFT	MOD	315	710	2165	3940
	SEV	190	430	1315	2385

RADIO OF MINE DETONATION AND AIR BLAST RADIO REDUCTION TABLES

RADIUS OF DETONATION OF VARIOUS US MINES-METERS

MINE TYPE	YIELD (KT)			
	.01	.5	10	50
M-6 A/T	95	210	645	1170
M-7 A/T	55	125	380	690
M-15 A/T	95	210	645	1170
M-14 A/P	140	320	975	1770

AIR BLAST RADIO REDUCTION DISTANCES-METERS

DOB (METERS)	YIELD (KT)			
	.01	.5	10	50
1	10	10	10	10
2	25	20	15	15
3		35	25	25
4		50	35	30
5		75	45	40
6			55	50
7			70	60
8			80	70
9			95	80
10			115	95
12			150	115
14			190	140

PIER AND ABUTMENT DEMOLITION TABLES

YIELD DETERMINATION FOR ADM EMPLACEMENT ON
FACE OF REINFORCED CONCRETE PIER. TOP OF REINFORCED PIER
OR ABUTMENT, OR TRAVELED WAY OVER REINFORCED CONCRETE PIER

MAXIMUM WIDTH (METERS) OF PIER (OR TRAVELED WAY).	YIELD (KT) REQUIRED TO BREACH WIDTHS INDICATED			
	.01	.5	10	50
	15	35	95	160

YIELD DETERMINATION FOR ADM EMPLACEMENT
ON FACE OF REINFORCED CONCRETE ABUTMENT

YIELD (KT)							
.01		.5		10		50	
T	W	T	W	T	W	T	W
3.0	15	7.0	35	19.0	95	32.0	160

YIELD DETERMINATION FOR ADM EMPLACEMENT BEHIND REINFORCED
CONCRETE ABUTMENT AT A DEPTH EQUAL TO OR GREATER THAN ONE
HALF THE ABUTMENT HEIGHT

ABUTMENT THICKNESS (METERS)	MAXIMUM ABUTMENT WIDTH IN METERS THAT CAN BE EFFECTIVELY DEMOLISHED			
	YIELD (KT)			
	.01	.5	10	50
0.75	25	45	100	160
2.25	30	55	120	190
4.60	35	60	135	210
7.60	40	70	150	230
10.70	40	75	165	250
13.70	45	75	170	265

OVERPRESSURE TABLES

RADI OF VARIOUS OVERPRESSURE LEVELS

DOB (METERS)	YIELD (KT)			
	.01 PSI			
	1	3	6	10
0	415	195	130	95
1	415	190	120	85
2	405	175	100	65
3	375	140	80	55
4	315	115	70	50
5	205	95	60	45
6	165	85	55	40
7	145	75	50	35
8	130	70	50	35

DOB (METERS)	YIELD (KT)			
	.5 PSI			
	1	3	6	10
0	945	445	295	215
1	945	440	290	210
2	945	435	280	200
3	935	425	270	180
4	925	410	255	160
5	905	380	215	140
6	875	345	195	130
7	835	315	180	125
8	785	285	165	120
10	615	240	145	105
12	430	210	135	95
14	365	190	125	90
18	295	160	110	75

DOB (METERS)	YIELD (KT)			
	10 PSI			
	1	3	6	10
0	2890	1365	905	655
1	2890	1360	900	650
2	2885	1355	895	650
3	2885	1350	885	650
4	2885	1345	875	645
5	2885	1335	870	635
6	2885	1330	860	615
7	2880	1325	850	600
8	2870	1315	835	580
9	2865	1310	825	560
10	2855	1295	815	540
12	2835	1265	785	490
14	2805	1210	700	445
18	2690	1065	605	405
22	2530	940	545	380
30	1990	745	455	330

DOB (METERS)	YIELD (KT)			
	50 PSI			
	1	3	6	10
0	5250	2480	1645	1195
1	5250	2480	1640	1190
2	5250	2475	1635	1185
3	5245	2470	1625	1185
4	5245	2460	1620	1185
5	5245	2455	1610	1180
6	5245	2450	1605	1180
7	5245	2445	1595	1175
8	5240	2435	1585	1165
9	5240	2430	1580	1155
10	5240	2425	1570	1135
12	5240	2410	1550	1100
14	5225	2395	1525	1065
18	5190	2355	1480	985
22	5155	2290	1415	890
30	4970	2040	1145	755

ADM YIELD DETERMINATION FOR
EMPLACEMENT DIRECTLY OVER TUNNEL

BURST TO TUNNEL DISTANCE (METERS)	MINIMUM YIELD (KT) ADM REQUIRED TO EXTEND ZONE II DAMAGE (SEVERE) FOR 30 METERS WITHIN A TUNNEL THROUGH A HARD-ROCK MEDIUM.								
	DOB=0M	DOB=1M	DOB=2M	DOB=3M	DOB=4M	DOB=5M	DOB=6M	DOB=8M	DOB=10M
10	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
12	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
14	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
16	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
18	10.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
20	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
25	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
30	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
35	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
40	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
45	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
50	50.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

NOTE - For an accessible tunnel, a 0.5 KT ADM placed on tunnel floor will close 30 meters of tunnel.

TREE BLOWDOWN OBSTACLE

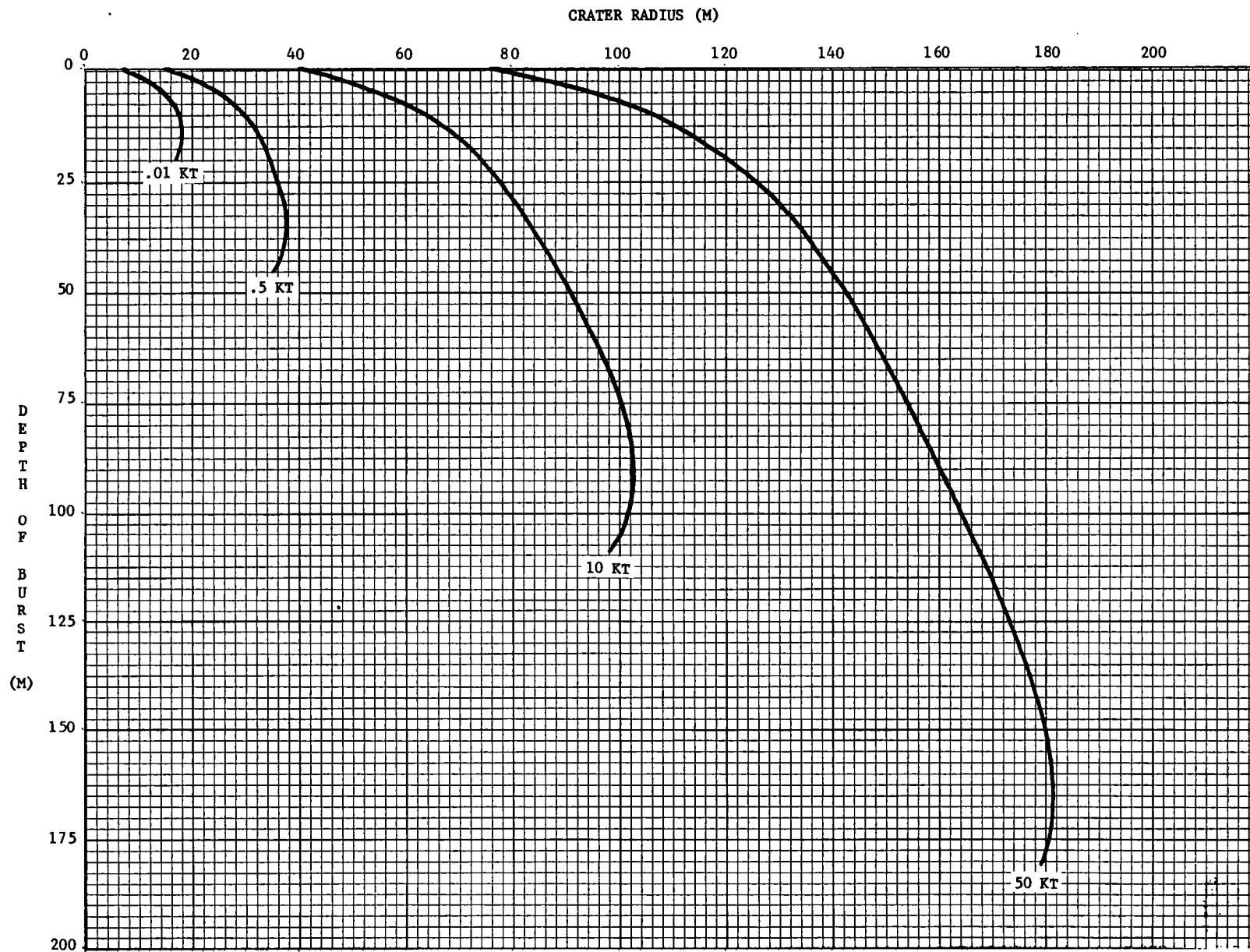
YIELD (KT)	DECIDUOUS	CONIFEROUS
0.01	70	65
0.50	195	195
10.00	790	700
50.00	1555	1430

SAFETY DISTANCES
LIGHT AIRCRAFT IN FLIGHT-METERS

YIELD (KT)	AIRCRAFT SAFETY DISTANCES
0.01	634
0.50	1439
10.00	4399
50.00	7994

CRATER GRAPH

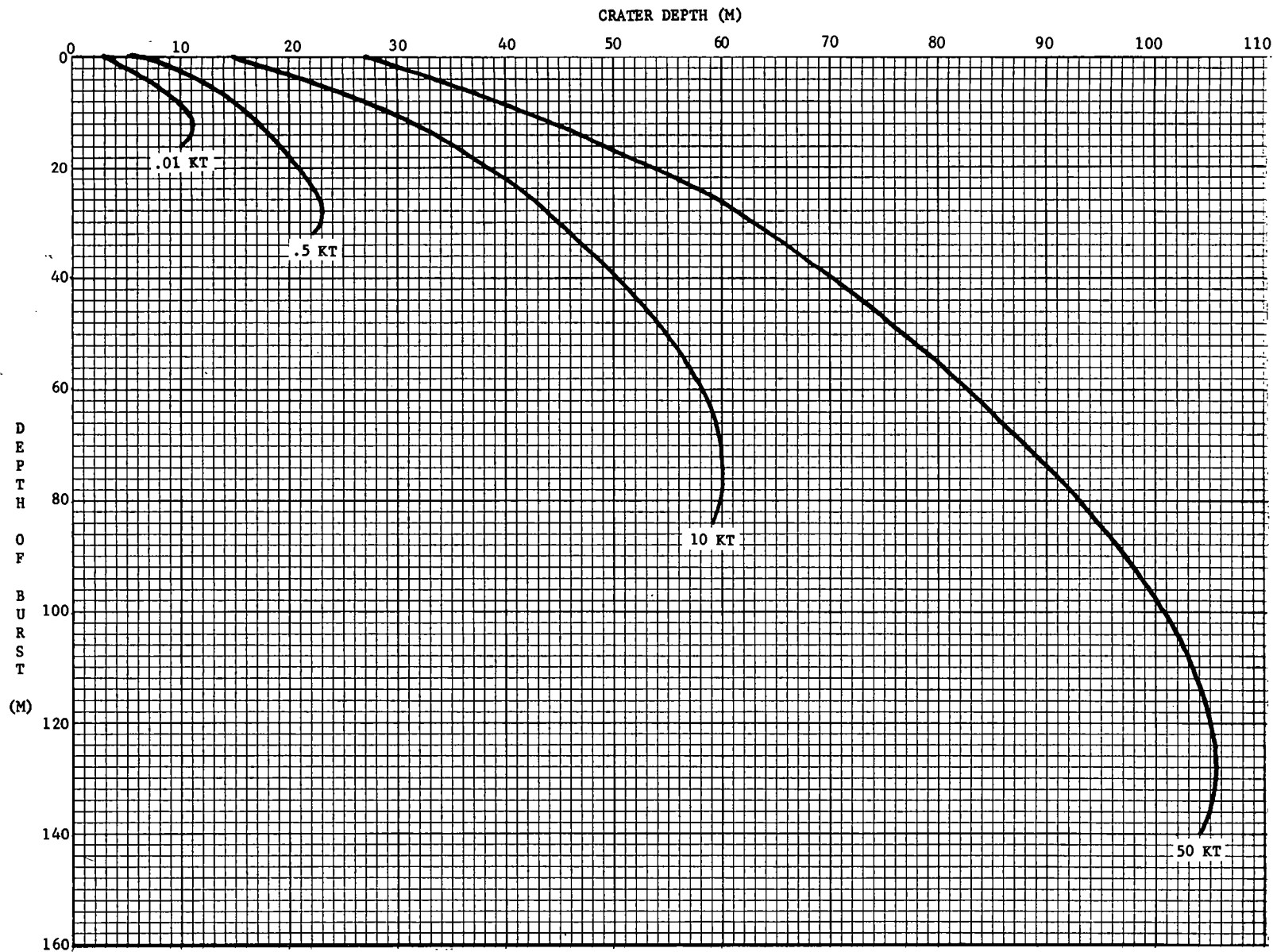
CRATER RADIUS (DRY SOIL OR SOFT ROCK)



NOTE: To obtain crater radii in hard rock or concrete, multiply crater radius (dry soil or soft rock) by 0.8.

CRATER GRAPH

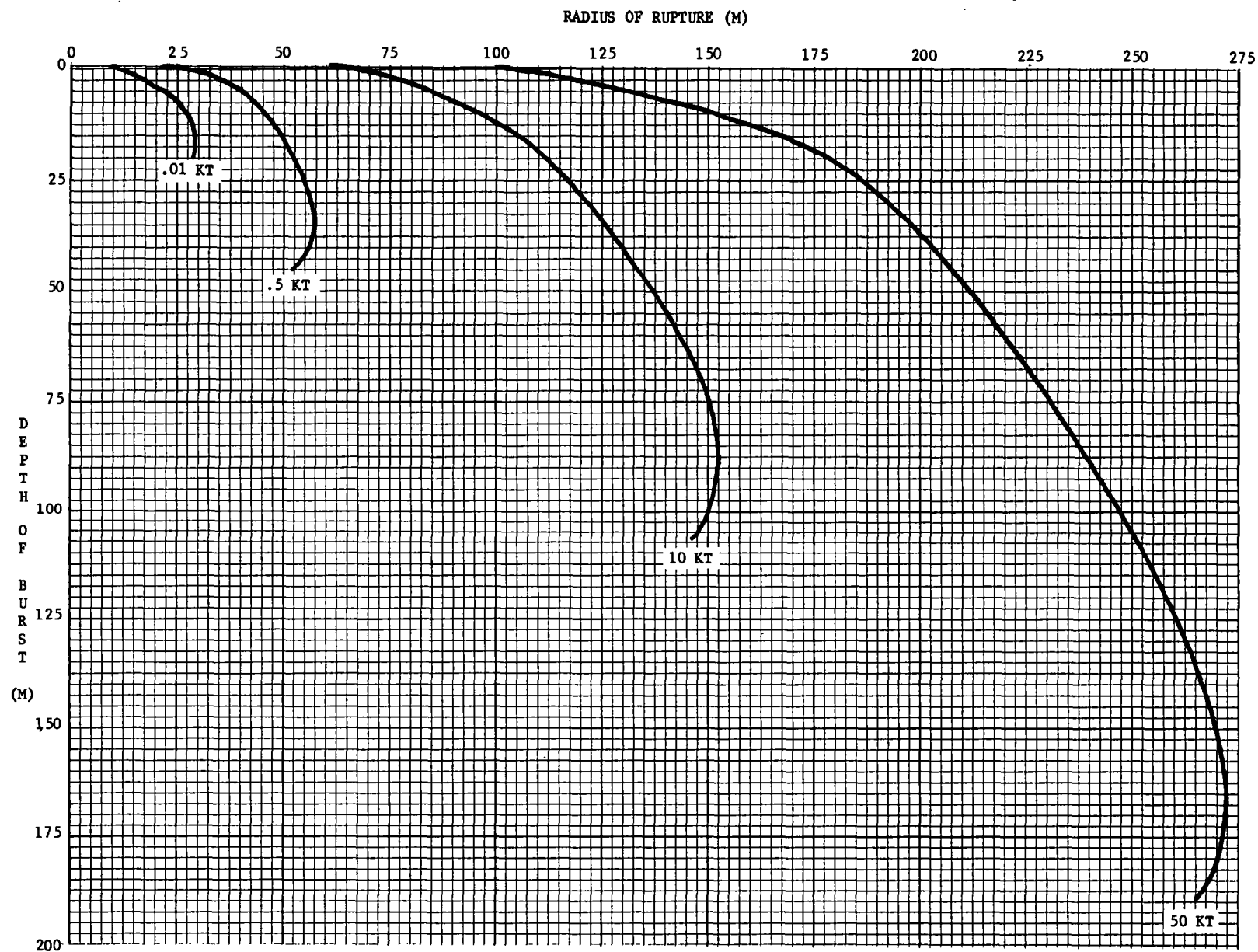
CRATER DEPTH (DRY SOIL OR SOFT ROCK)



NOTE: To obtain depth of crater in hard rock or concrete,
multiply depth of crater (dry soil or soft rock) by 0.8.

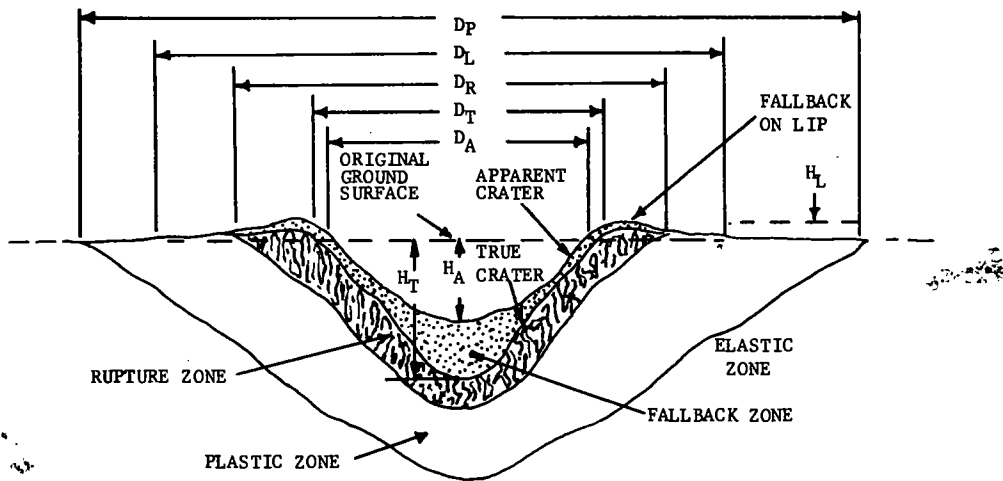
CRATER GRAPH

RADIUS OF RUPTURE (DRY SOIL OR SOFT ROCK)



NOTE: To obtain radii of rupture in hard rock or concrete, multiply radius of rupture (dry soil or soft rock) by 0.8.

CRATER PROFILE



D_A = DIAMETER OF APPARENT CRATER

H_A = DEPTH OF APPARENT CRATER

D_T = DIAMETER OF TRUE CRATER

H_T = DEPTH OF TRUE CRATER

D_L = DIAMETER OF LIP = $2.0 D_A \pm 25\%$

R_A = RADIUS OF APPARENT CRATER = $\frac{D_A}{2}$

R_C = RADIUS OF CAVITY

$R = 45(W)^{1/3}$ FT OR $14 (W)^{1/3}$ METERS

H_L = HEIGHT OF LIP = $0.25 H_A \pm 50\%$

D_R = DIAMETER OF RUPTURE ZONE = $1.5 D_A \pm 25\%$

D_P = DIAMETER OF PLASTIC ZONE = $3 D_A \pm 50\%$

V_C = VOLUME OF APPARENT CRATER = $\frac{\pi}{2} H_A (R_A)^2$

H_T = DOB + R_C

RADII OF SAFETY TABLES

RADIUS OF SAFETY, .01 KT						
DOB	UNWARNED EXPOSED		WARNED EXPOSED		WARNED PROTECTED	
	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK
0	1200	800	1200	800	900	600
1	1200	800	1200	800	900	600
2	1200	800	1200	800	900	600
4	1200	900	1200	900	900	900
6	1100	800	1100	800	900	800
8	1000	700	1000	700	800	700
10	900	600	900	600	700	600
14	700	500	700	500	600	500
25	200	100	200	100	200	100
45	100	100	100	100	100	100

RADIUS OF SAFETY, 0.5 KT						
DOB	UNWARNED EXPOSED		WARNED EXPOSED		WARNED PROTECTED	
	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK
0	1600	1200	1600	1200	1400	1000
1	1600	1200	1600	1200	1400	1000
2	1600	1200	1600	1200	1400	1000
4	1600	1200	1600	1200	1400	1000
6	1600	1400	1600	1400	1400	1400
8	1700	1700	1700	1700	1700	1700
10	1800	1800	1800	1800	1800	1800
14	1600	1600	1600	1600	1600	1600
25	1200	1200	1200	1200	1200	1200
45	600	600	600	600	600	600

RADIUS OF SAFETY, 10.00 KT						
DOB	UNWARNED EXPOSED		WARNED EXPOSED		WARNED PROTECTED	
	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK
0	3400	2700	2400	1900	2100	1600
1	3400	2700	2400	1900	2100	1600
3	3400	2700	2400	1900	2100	1600
5	3400	2700	2400	1900	2100	1600
7	3400	2700	2400	1900	2100	1600
10	3400	2700	2400	1900	2100	1900
14	3300	3000	3000	3000	3000	3000
18	3700	3700	3700	3700	3700	3700
30	4800	4800	4800	4800	4800	4800
65	3700	3700	3700	3700	3700	3700
100	2700	2700	2700	2700	2700	2700

RADIUS OF SAFETY, 50.00 KT						
DOB	UNWARNED EXPOSED		WARNED EXPOSED		WARNED PROTECTED	
	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK	NEG RISK	EMERG RISK
0	8500	6400	4400	3700	2600	2200
1	8500	6400	4400	3700	2600	2200
3	8500	6400	4400	3700	2600	2200
5	8500	6400	4400	3700	2600	2200
7	8500	6400	4400	3700	2600	2200
10	8500	6400	4400	3700	2600	2200
14	8500	6400	4400	3700	2600	2200
18	8500	6400	4400	3700	3200	3200
30	8200	6200	5800	5800	5800	5800
65	8000	8000	8000	8000	8000	8000
100	7000	7000	7000	7000	7000	7000

NOTE - Tables above show distances for initial effects only. A fallout prediction is necessary.

RADIUS OF FIRE AREAS SURFACE AND SUBSURFACE BURSTS

		50 PERCENT RELATIVE HUMIDITY	
YIELD	DOB	DRY FUEL	GREEN FUEL
0.01	0	150	95
	3	140	90
	5	130	80
	10	100	65
	15	75	45
0.50	0	435	275
	3	435	275
	5	425	265
	10	390	245
	15	350	220
10.00	0	2170	1360
	5	2170	1360
	10	2170	1360
	15	2120	1330
	20	2060	1290
	25	2000	1255
	30	1940	1220
	35	1885	1180
50.00	0	5185	3250
	5	5185	3250
	10	5185	3250
	15	5185	3250
	20	5180	3250
	25	5100	3200
	30	5025	3150
	35	4945	3100

RADIATION TRANSMISSION FACTOR TABLE

Protection	Initial		Residual
	Neutrons	Gamma	
Armored carrier	0.7	0.7	0.6
Built-up city area (in open)	1.0	0.5	0.7*
Foxholes	0.3	0.2	0.1
Frame house			
First floor	1.0	0.9	0.5
Basement	0.5	0.3	0.1
Multistory buildings			
Top floor	1.0	0.9	0.1
Intermediate floors	0.9	0.9	.02
Lower floor	0.9	0.5	0.1
Basement	0.5	0.3	.01
Shelter, closed (3 ft earth cover)	0.05	0.02	0.005
Tanks			
Light	0.3	0.2	0.2
Medium	0.3	0.1	0.1
Trucks			
1/4-ton	1.0	1.0	0.8
3/4-ton	1.0	1.0	0.7
2 1/2-ton	1.0	1.0	0.6
4-7 ton	1.0	1.0	0.5
Woods	1.0	1.0	0.8*

*NOTE: These transmission factors do not apply to ground survey doses.

RADI OF INDUCED CONTAMINATION TABLE

ESTIMATED 2 RAD/HR RADIUS OF INDUCED
CONTAMINATION

YIELD	HORIZONTAL RADIUS
1 KT	400 meters
10 KT	700 meters
100 KT	1000 meters
1 MT	1400 meters

NOTE: To determine the approximate distance from ground zero at which radiation measuring instruments should be used, enter the above table at the nearest listed yield.

RESIDUAL RADIATION TRANSMISSION FACTORS FOR TROOP SAFETY

M60 Tank	0.04
M482A Tank	0.02
M59 APC	0.2
M113 APC	0.3
M116 Cargo Carrier	0.6
M548 Cargo Carrier	0.7
M114 Reconnaissance Vehicle	0.3
M108 SP Howitzer	0.3
M109 SP Howitzer	0.2
XM104 SP Howitzer	0.5
M107 SP Gun	0.4
M88 Recovery vehicle	0.09
M577 Command Post Carrier	0.3
XM551 Armored Reconnaissance/ Airborne Assault Vehicle	0.2
M728 Combat Engineer Vehicle	0.04

GLOSSARY

This glossary is the same as provided in FM 101-31-1. It is reproduced in this manual for the convenience of the nuclear targetanalyst. Terms that appear in JCS Pub 1 and AR 380-5 are not reproduced herein.

Across the board -- Used in connection with weapon effects curves. It indicates that consideration is given to all the effects curves that describe radiation doses, blast effects on various drag-type targets, thermal effects, and overpressures.

Atmospheres -- A measure of normal atmospheric pressure (e.g., 2 atmospheres indicate two times the normal atmospheric pressure).

Graphical portrayal -- A two-dimensional representation (generally to scale) of the distance that the normal atmospheric pressure specified effects extend. It is also a visual representation of the results of an analysis.

Militarily significant weapon effects -- Those effects that will have a definite influence on the military capabilities or the degree of risk. See also Tactically significant weapon effects.

Minimum-dose exit route -- The route of egress from a radioactive-contaminated area that presents the smallest amount of radiation to the exiting party or parties.

Nonsymptomatic dose -- A dose of radiation that may not be detected because the recipient does not display the behavior or physical characteristics that would normally accompany such a dose.

Readiness status -- Indicates the degree of preparation of both the weapon and the delivery unit for delivery of nuclear fires (to include air-delivered weapons).

Soft targets -- Those targets that are easily damaged by nuclear weapon effects, e.g., exposed personnel, most buildings (particularly frame), forests and crops.

Tactically significant weapon effects -- Those effects that will have a definite influence on the military action currently underway. See also Militarily significant weapon effects.

Weapon -- An assembled and ready-for-delivery nuclear device in the military configuration. For artillery, a weapon is a complete round; for a rocket, the motor plus the warhead; for a missile, the complete missile, to include the warhead; for an air-delivery weapon, the warhead in the bomb; and for an atomic demolition munition, the complete munition. See also Weapon system.

Weapon system -- The complete weapon plus the associated delivery means. See also Weapon.

Worst-case burst -- In analyzing targets, it indicates the location of the burst that occurs at the outer limits of the acceptable dispersion in both range and elevation. In considering the vulnerability of friendly forces, it indicates the point of maximum damage.

By Order of the Secretaries of the Army and the Navy:

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